CGIAR | INITIATIVE ON Genebanks

CGIAR Research Initiative on **Genebanks**

Annual Technical Report 2023

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Disclaimers

This publication has been prepared as an output of the CGIAR Research Initiative on Genebanks. Any views and opinions expressed in this publication are those of the author(s) and are not necessarily representative of or endorsed by the CGIAR System Organization.

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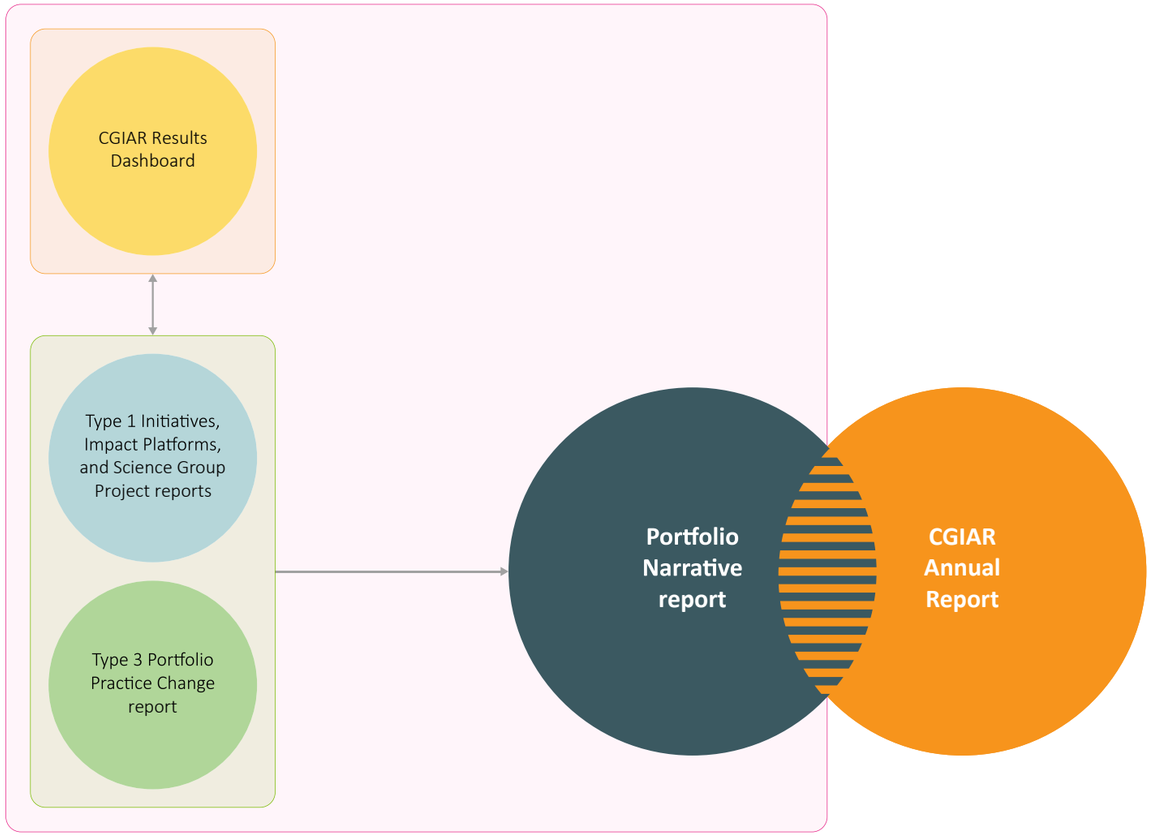
CGIAR Technical Reporting 2023

CGIAR Technical Reporting has been developed in alignment with the CGIAR Technical Reporting Arrangement. This Initiative report ("Type 1" report) constitutes part of the broader CGIAR Technical Report. Each CGIAR Research Initiative submits an annual "Type 1" report, which provides assurance on Initiative-level progress towards End of Initiative outcomes.

The CGIAR Technical Report comprises:

- Type 1 Initiative, Impact Platform, and Science Group Project (SGP) reports, with quality assured results reported by Initiatives, Platforms and SGPs available on the CGIAR Results Dashboard.
- The Type 3 Portfolio Performance and Project Coordination Practice Change report, which focuses on internal practice change.
- The Portfolio Narrative, which draws on the Type 1 and Type 3 reports, and the CGIAR Results Dashboard, to provide a broader view on Portfolio coherence, including results, partnerships, country and regional engagement, and synergies among the Portfolio's constituent parts.

The CGIAR Annual Report is a comprehensive overview of CGIAR's collective achievements, impact and strategic outlook, which draws significantly from the Technical Report products above. For 2023, the Annual Report and Technical Report will be presented online as an integrated product.



Section 1: **Fact sheet and budget**

Initiative name	Genebanks
Initiative short name	Genebanks
Initiative Lead	Charlotte Lusty (c.lusty@cgiar.org)
Science Group	Genetic Innovation
Start – end date	01/01/2022 – 31/12/2024
Geographic scope	Global
OECD DAC Climate marker adaptation score[1]	**Score 2: Principal** The activity is principally about meeting any of the three CGIAR climate-related strategy objectives – namely, climate mitigation, climate adaptation and climate policy, and would not have been undertaken without this objective.
OECD DAC Climate marker mitigation score[1]	**Score 1: Significant** The activity contributes in a significant way to any of the three CGIAR climate-related strategy objectives – namely, climate mitigation, climate adaptation and climate policy, even though it is not the principal focus of the activity.
OECD DAC Gender equity marker score[2]	**Score 0: Not targeted** The initiative/project has not been found to target gender equality. However, as a minimum requirement for all initiatives/projects, (i) a gender analysis was conducted, (ii) its findings should be used to ensure at minimum that the initiative activities/interventions do no harm and does not reinforce gender inequalities, and (iii) data that is collected is gender disaggregated.
Website link	https://www.cgiar.org/initiative/03-conservation-and-use-of-genetic-resources-genebanks/

[1] The Organisation for Economic Co-operation and Development (OECD) Development Assistance Committee (DAC) markers refer to the OECD DAC Rio Markers for Climate and the gender equality policy marker. For climate adaptation and mitigation, scores are: 0 = Not targeted; 1 = Significant; and 2 = Principal.

[2] The CGIAR Gender Impact Platform has adapted the OECD gender marker, splitting the 1 score into 1A and 1B. For gender equality, scores are: 0 = Not targeted; 1A = Gender accommodative/aware; 1B = Gender responsive; and 2 = Principal.

These scores are derived from Initiative proposals, and refer to the score given to the Initiative overall based on their proposal.

EXECUTIVE SUMMARY

The CGIAR Research Initiative on Genebanks builds firmly on the Genebank CGIAR Research Program and Platform that preceded it, strengthening the operations of the genebanks and the security and composition of the collections, and strengthening the communities of expertise that manage and make use of them. The value of the genebanks' communities was recognized in the 2023 Independent Advisory and Evaluation Service (IAES) evaluation of the Genebank Platform. The evaluation panel recommended a review of the scientific impact of genebank communities of practice (CoPs) as an exemplary model for disseminating lessons learned. Overall, 38 nearly all highly positive findings were made in the evaluation report and the panel found that "many Platform interventions have been transformative, having resulted in substantial improvements in many aspects of genebank operations including facilities, systems and working culture."

Continuing to strengthen CoPs in 2023, the first gathering of genebank technical staff across Centers was convened in Ethiopia since COVID-19 hit. Significant strides were made to harmonize genebank workflows as the basis for increasing the alignment of data and quality management across Centers, following a similar model used in breeding. Genotypic data resources on more than 20,000 accessions are now collated in the same software platform, GIGWA, and high throughput technology is being mainstreamed across genebanks for seed phenotyping. Aligning digital resources and systems in this way allows us to move towards a shared vision of harmonized resources for exploring, selecting and ordering the germplasm of diverse crops from CGIAR genebanks.

Genebank use in 2023 increased sharply mainly due to a new artificial intelligence (AI) technology proving able to automate accession identification and allow large-scale screening of diversity for desired traits. More than 200,000 samples were disseminated to nearly 1,000 users in 68 countries. Trends in bilateral funding to genebanks and related research also suggest that wide-scale screening of collections for specific traits to tackle climate change challenges and emerging or intractable pests and diseases is becoming more feasible. AI may help users to select germplasm more precisely, but it also appears to be enabling "big screening" of collections.

Our NARS partners are benefitting from CGIAR genebank CoPs and breakthroughs. Regional workshops, one-on-one backstopping, joint projects and intensive follow-up are helping new technologies and best practices spread and improve. The Initiative's partnerships are also helping secure national collections and national plant protection agencies and to improve operations and resources to maintain and exchange genetic resources. Coordinated regional approaches to analyzing genetic diversity of crop collections in diversity hotspots provide an opportunity to address Sustainable Development Goal (SDG) 2.5 much more effectively.

As an endorsement of CGIAR's global role, the Governing Body of the International Treaty on Plant Genetic Resources for Food and Agriculture (Plant Treaty) called on CGIAR in 2023 to expand their support to countries specifically to manage and use digital sequence information (DSI).

Finally, ICRISAT and CIFOR-ICRAF genebank staff continue to be involved in Initiative meetings and capacity building activities and the partial funding of the ICRISAT genebank made it possible to fully re-engage ICRISAT within the Initiative by the end of 2023.

	2022	**2023**	2024
PROPOSAL BUDGET	$25.72M	**$25.78M**	$26.49M
APPROVED BUDGET [1]	$22.41M	**$23.88M** [2]	$23.98M [3]

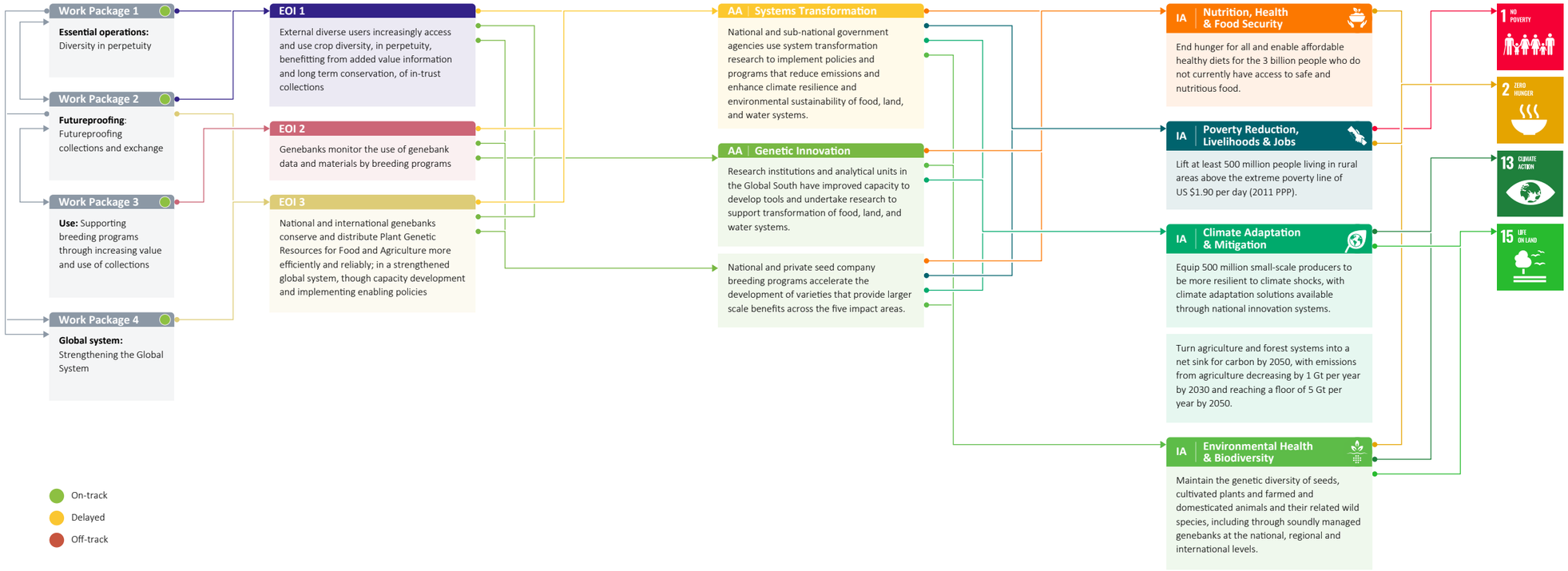
[1] The approved budget amounts correspond to the figures available for public access through the Financing dashboard.
[2] This amount includes carry-over and commitments.
[3] This amount is an estimation of the 2024 annual budget allocation, as of the end of March 2024.

Maize landraces conserved at CIMMYT.
Credit: CIMMYT

Section 2: **Progress on science and towards End of Initiative outcomes**

Initiative-level theory of change diagram

This is a simple, linear, and static representation of a complex, non-linear, and dynamic reality. Feedback loops and connections between this Initiative and other Initiatives' theories of change are excluded for clarity.



EOI	End of Initiative outcome
AA	Action Area
IA	Impact Area
SDG	Sustainable Development Goal

Note: A summary of Work Package progress ratings is provided in Section 3.

Marie-Noelle Ndjiondjop, Manager at the Rice Biodiversity Centre for Africa, and her team.
Credit: Neil Palmer, Crop Trust

Summary of progress against the theory of change

In 2023, the CGIAR Research Initiative on Genebanks provided more than 200,000 germplasm samples to 993 requestors in 68 countries, (not including distributions from CIFOR-ICRAF). The largest percentage of external distributions was for research, received by universities and advanced research institutes. India, the Philippines, Viet Nam, Syrian Arab Republic and Nigeria were the top five recipient countries in 2023, receiving 68 percent of the samples distributed externally.

More than 8,400 samples of beans, cassava, forages, maize, potato, pearl millet, rice and sweetpotato were disseminated to farmers, NGOs and farmer organizations in Benin, Chad, Colombia, Ethiopia, Guatemala, India, Lebanon, Mexico, Peru, the Philippines, Singapore, Tonga and the United States of America. A total of 2,774 samples were sent to commercial sector users in 24 countries. CGIAR breeders and researchers received 68 percent of the disseminated germplasm for research and breeding. Every germplasm import and export, including from breeding programs, passed through CGIAR Germplasm Health Units (GHUs), which carried out more than 830,000 diagnostic assays and prevented the movement of more than 10,000 diseased or contaminated samples, ensuring compliance with national phytosanitary regulations. With the support of the Genebanks Initiative's Policy Team, all CGIAR acquisitions and distributions are compliant with national and international policies and laws.

In total, the ten reporting CGIAR genebanks (not including CIFOR-ICRAF) conserve 716,394 accessions in the form of seeds, tissue culture, tubers, cryopreserved samples, trees and plants in the field and screenhouse. Four Centers (AfricaRice, CIAT, IITA and IRRI) manage seed collections that have sustained performance targets for availability, safety duplication, documentation and quality management. Targets were agreed in 2014 after a quantitative assessment of the collections' status and recommendations from external reviewers. All the collections are in a better state of health and security. They are more resilient with fewer backlogs and materials requiring urgent attention. The six-person panel of the Independent Advisory and Evaluation Service (IAES), after conducting visits, undertaking a large-scale survey and more than 100 interviews in 2023, concluded in its report that genebank performance and collections' conservation status have significantly improved and that large steps have been taken towards addressing SDG 2.5. One of the 38 findings also recognizes that there is evidence of cost savings since 2012.

The AfricaRice genebank has reached performance targets and ICARDA-Morocco and ICRISAT genebanks will reach targets in the next two years. AfricaRice manages a unique collection of rice species and varieties indigenous to Africa. Previously, it was managed as fragmented collections hosted in IITA facilities in Benin and Nigeria. In the space of seven years, the collection has been consolidated in Bouake, Cote D'Ivoire, in a custom-made facility with a GHU, screenhouses for wild species and fields for regeneration. The collection composition and processes have been optimized, new staff trained and now the genebank has reached performance targets and is leading on dormancy-breaking research and new technologies like high-throughput seed phenotyping.

The CIP genebank has made a breakthrough in establishing the legal availability of its extraordinary collection of nine Andean roots and tuber species. However, the legal status of the collection is not the only limiting factor to distributing the germplasm since phytosanitary protocols are not yet established for these diverse species to ensure the safe movement of tissue culture samples. Protocol optimization is now in progress at CIP and the genebank responds, where it can, to requests worldwide by distributing seeds of these species.

A multispectral imaging technology, developed by a small company in Denmark called Videometer, has been adopted by seven CGIAR genebanks and trained on eight crop species. In 2023, genebank technicians were trained and worked to build capacity to use the scanner and manage the generated images. Procedures and terminology will be harmonized. The new technology enables the high-definition characterization of seed morphology and color, which can be used in precise accession identification, taxonomic classification, assessment of health and viability, and evaluation of seed-related traits. GHUs are also adopting the same technology for pest and disease diagnostics.

Efforts to adopt GRIN-Global CE (GGCE) as the primary data management system (DMS) at scale across CGIAR genebanks have illustrated that genebanks' individual work to develop software and apps does not deliver obvious benefits for other Centers or the group as a whole, nor has it been possible to retire legacy systems. GGCE and its parent system GRIN-Global, are designed as data repositories. However, genebanks require systems that contribute to managing dynamic processes and quality control. Such systems have served a minority of genebanks for many years and have proved their worth in sustaining high quality historical data and aiding large teams in implementing genebank operations. In 2023, a landmark workshop took place, hosted by ILRI, where leaders in specific genebank processes from across Centers met to determine whether and where workflows could be harmonized across seed genebanks to form the basis for building a better shared data management system. It was no surprise to find a large degree of harmonization since CGIAR genebanks have co-invested in documenting processes and complying with international standards since 2014. However, the workshop illustrated subtle differences in approaches and terminology that make adopting the same DMS challenging. The newly formed Process Teams will continue to work on harmonization as a basis for GGCE improvement and wide-scale adoption. The genebanks will also contribute to the Quality Management System (QMS) harmonization work occurring across the Genetic Innovation Science Group.

A sweet spot in modern-day genebanking occurs where powerful digital resources serve more than one critical purpose, contributing to more effective collection curation and facilitating the discovery of genetic variation in sought-after traits at the same time. However, ensuring existing data associated with individual accessions is accurate and useful continues to be a challenge. Collection curators work continually on data accuracy, integrity and recovery, on trawling accession data from grey and published sources, generating new data and creating tools to make it accessible. Bioversity has developed a molecular atlas of banana accessions illustrated by chromosome painting. Banana domestication is considerably more complicated than previously thought with up to seven wild *Musa* species contributing genetic diversity and traits to different cultivar groups, including at least one still unknown parent. The atlas will allow researchers to investigate unique sources of genetic variation in the collection for potentially useful traits. Similar molecular resources and catalogues are developed by other Centers. Genotypic data, however, are now being brought under a single platform in GIGWA, where they may be managed and made accessible. In 2023, seven Centers pooled their genotypic data this way to create a unified resource of genetic markers across eight crop species.

To strengthen the global system of genebanks, directly addressing SDG 2.5, more than 60 NARS partners were engaged in capacity building and collaboration under Work Package 4, covering a range of genebank operations and activities from cryopreservation to the use of genomic tools for collection management and use. Fifteen NARS partners benefited from project funding to develop capacity in genebank operations and international policy implementation. Regional workshops were designed to respond to priority capacity building needs for Sub-Saharan Africa, Central and Western Asia and North Africa and Latin America. These workshops have helped to extend the reach of communities of practice (CoPs) on the themes of using genotypic data to manage collections and cryobanking as well as general genebank operation. Eleven institutes in Central and South America have pooled resources to genotype and map genetic diversity of their respective collections of beans, maize, cassava, potato and wheat. Several partners are entering into collaborations with CIP to cryopreserve their clonal crop collections.

Chromosome painting of banana accessions is unveiling new genetic relationships between well-established landraces and wild banana species.
Credit: Crop Trust

It was a busy year for international meetings with the Governing Bodies of both the Commission on Genetic Resources for Food and Agriculture (CGRFA) and the International Treaty on Plant Genetic Resources for Food and Agriculture (Plant Treaty) meeting in Rome in 2023. CGIAR contributions and reports were commended. At the end of the Plant Treaty meeting, the 151 Contracting Parties unanimously adopted a resolution that "acknowledges the technical assistance undertaken by the CGIAR Centers in order to reduce the existing gap on capacity regarding generation, access to and use of digital sequence information and recommends that this work be continued and strengthened".

Progress by End of Initiative outcome

EOIO 1: External diverse users increasingly access and use crop diversity, in perpetuity, benefitting from added value information and long-term conservation, of in-trust collections.

Good progress has been made against the goal to secure collections under CGIAR management in long-term conservation for availability to diverse users in perpetuity. Four genebanks have collections at performance targets and two will reach targets in 1-2 years. Three have in-perpetuity funding from the Crop Trust. Genebanks are further harmonizing workflows as the basis of a more effective, unified data management system and service offer to users.

EOIO 2: Genebanks monitor the use of genebank data and materials by breeding programs.

Genebanks work continually to enrich accession-level information and develop more powerful accession selection methods. An online sub-setting tool to identify germplasm based on environmental variables continues to be refined. Genebanks respond to breeders' information needs. Georeference, phenotypic and genotypic data are being improved and collated to enhance environmental genomewide association studies (EnvGWAS) and other research.

EOIO 3: National and international genebanks conserve and distribute Plant Genetic Resources for Food and Agriculture more efficiently and reliably; in a strengthened global system, though capacity development and implementing enabling policies.

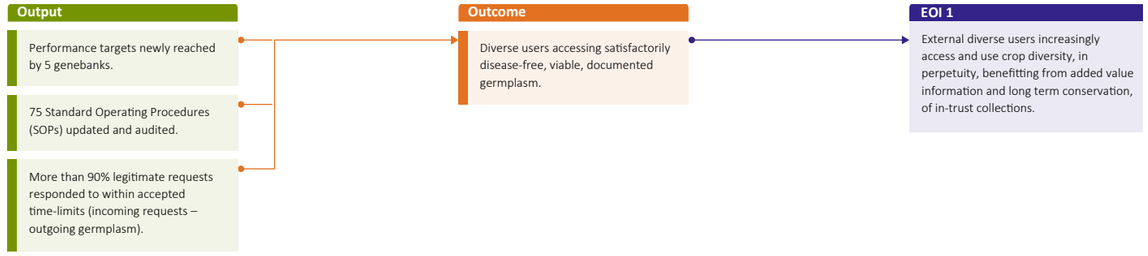
More than 60 NARS partners have been engaged for diverse capacity building activities, undertaken to strengthen the global system for plant genetic resources conservation and use and to address SDG 2.5. CGIAR has been recognized as a critical partner for capacity building in digital sequence information by the Plant Treaty.

Characterising wheat diversity at CIMMYT.
Credit: Photo CIMMYT

Section 3: **Work Package progress**

WP1: Diversity in perpetuity (Essential operations)

On track



Work Package 1 progress against the theory of change

CGIAR genebanks carried out routine operations to ensure that crop collections are conserved and made available upon request. Seed lots and tissue culture samples were regenerated and multiplied in the field, screenhouse and laboratory (140,000 samples in 2023), viability tested (167,000), health tested (43,000) and disease cleaned (8,000). New materials were received or accessioned (1,758 accessions) from Brazil, French Polynesia, Niger, Papua New Guinea, Peru, South Sudan, Togo, the United Kingdom and Zambia, as well as from CGIAR breeders.

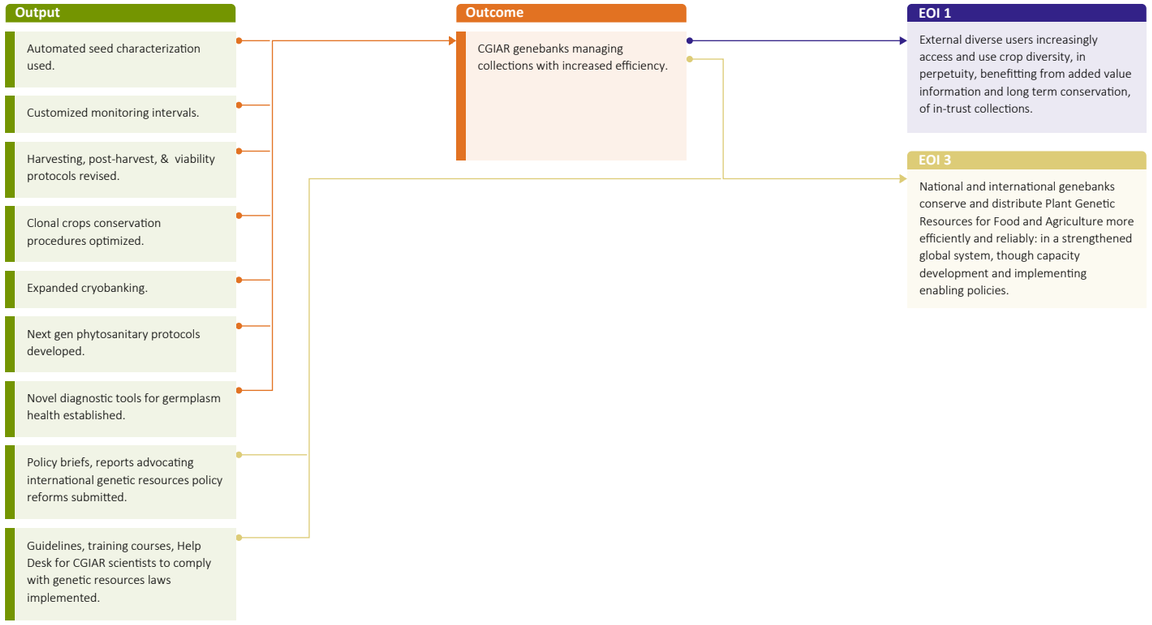
In 2023, 209,711 germplasm samples were distributed to 68 countries, 32 percent were sent in response to nearly 1,000 requests from users outside CGIAR, mostly for research and characterization (72 percent). Of those samples sent externally, 44 percent went to advanced research institutes and universities, 38 percent went to NARS, 13 percent to farmers, NGOs and farmer organizations, and 4 percent to the commercial sector (see Section 4).

Four genebanks are sustaining performance targets for their seed collections. The Crop Trust provided USD 5 million bilaterally to individual CGIAR genebanks (including ICRISAT) in 2023 in long-term funding, including three long-term partnership agreements, which fund essential operations. Overall, 82 percent of the collections are physically and legally available and 80 percent are safety duplicated (target is 90 percent). Significant progress was made in re-inventorying and rationalizing seed lots and accessions notably at CIMMYT and ILRI. This involved a record number of annual viability tests as seed packages were re-tested, cleaned and re-packaged. In 2023, 117 newly drafted or improved operating procedures were mainstreamed as a result of research and optimization undertaken in Work Package 2.

GHUs in nine CGIAR Centers processed 212,465 accessions and 162,461 samples to facilitate 1379 import/export events with 134 countries, of which 59 percent were for CGIAR breeders and the rest for genebanks.

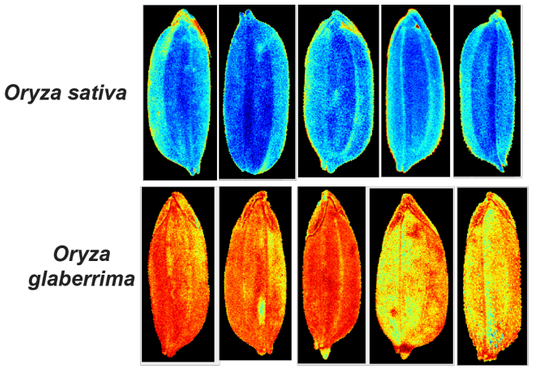
WP2: Futureproofing collections and exchange (Futureproofing)

On track



Work Package 2 progress against the theory of change

The seed quality management CoP, initiated in 2017 to support piloting of improved technologies and protocols for maximizing seed quality and longevity across all genebanks. In 2023, VideometerLab instruments were installed in four locations for multispectral imaging of seeds and are now in use in seven genebanks. More than 10,000 accessions of diverse crops have been imaged and models are being developed for characterization and classification. The classifiers developed for rice at AfricaRice have 98 percent accuracy.



Species discrimination using VideometerLab Software Analysis (nCDA)

In 2023, 572 accessions of banana, cassava, potato and sweetpotato were cryobanked. Conservation protocols are under trial for taro, cassava, coconut, sweetpotato, yam, ulluco, oca and mashua, and for seed conservation of wild species of banana and potato. More than 2,000 genetically very similar or potentially identical accessions have been identified and targeted for curation action. Results from joint genotyping of cassava collections at IITA and CIAT have indicated that there is greater redundancy within collections than between them.

After successful collaboration between GHUs working on clonal crops to develop high-throughput sequencing of sRNA for virus diagnostics, protocols are mainstreamed and are enabling substantial gains in time taken for virus testing. However, this powerful technique is also revealing cryptic viruses about which little is known. GHU leaders are collaborating to address how to safely manage results provided by these hyper-diagnostic tools. Essential work is also being done to test new seed treatments as alternatives for recently banned substances.

CGIAR submitted reports to the Plant Treaty, the CGRFA and the Convention on Biological Diversity (CBD). The Governing Body of the Plant Treaty met in November 2023 for its tenth session. Delegates adopted resolutions to support CGIAR's capacity-building work on both DSI and Plant Treaty implementation and called for an expansion of this activity.

WP3: Supporting breeding programs through increasing value and use of collections (Use)

On track

Work Package 3 progress against the theory of change

CGIAR genebanks accumulate data resources for diversity analyses, germplasm selection and collection management. More than 30 crops and 3,000 species are conserved. Their uses in research and breeding are wide-ranging. Approaches by individual genebanks to enriching data are mostly tailored to the specific crops and their potential uses. In 2023, activities included:

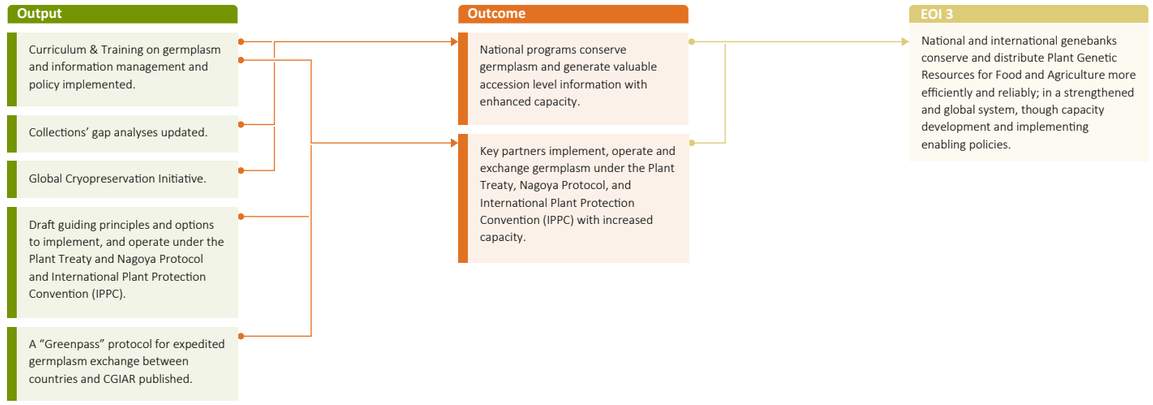
- Digitizing seed and plant images, correcting and generating georeferences and other passport data for thousands of accessions, making updated data available online and on Genesys (www.genesys-pgr.org).
- Generating genotypic data on potato crop wild relatives, banana, rice wild relatives, oca, ulluco and cassava to develop molecular atlases, carry out chromosome painting and diversity analyses, identify potential duplicates and taxonomic and subgroup classifications.
- Developing and evaluating 30 subsets of banana, barley, Buffel grass, lentil, potato, cassava, cowpea, sweetpotato, potato, wheat, yam and other crops to identify abiotic, biotic and nutritional traits in partnership with NARS and CGIAR breeders (e.g. for drought and heat tolerance, near-infrared reflectance spectroscopy (NIRS) profiling and resistance to numerous diseases, etc.).
- Carrying out EnvGWAS for climate-related traits in wheat and sweetpotato, complementing the analyses funded by the Bill & Melinda Gates Foundation.
- Imaging rice panicles of 100,000 accessions to train an AI model to identify accession types, facilitating large-scale screening of collections for traits such as disease tolerance.

Genotypic data management is being harmonized for genebanks using the GIGWA information system, the same database engine adopted by the Enterprise Breeding System (EBS). Sharing genotypic datasets in this common platform is unlocking access to 65 million single nucleotide polymorphism (SNP) markers spanning more than 20,000 genebank accessions across eight crops. This represents a significant step towards a digitized diversity resource that will facilitate allele mining for trait and use as well as inform collection curation.

Oca, an Andean tuber crop known for growing in harsh environments, is conserved in CIP's genebank. Genotypic studies in 2023 are providing more in-depth knowledge of the crop.
Credit: CIP

WP4: Strengthening the global system (Global system)

On track



Work Package 4 progress against the theory of change

WP4 enables CGIAR genebanks to respond to needs expressed by NARS. Agreements are now in place between individual Center genebanks and 15 NARS partners to strengthen genebank operations, improve collection composition and implement international policy. Six countries are being supported to strengthen implementation of the Plant Treaty's Multilateral System of Access and Benefit Sharing (MLS). National consultations have been held with all the participating countries to explore how they can develop policies to adhere to and benefit from the MLS. By the end of 2024, all six are expected to have drafted laws to implement the Plant Treaty. Letters of Agreement (LOAs) with nine countries were signed in 2023 to support genebank operations including germplasm collection, conservation, regeneration and characterization.

In 2023, 8,653 people visited CGIAR genebanks. A total of 148 PhD, MSc and BSc students were hosted by genebanks, and 87 training events took place with 1,016 participants from 65 countries, including:

- Genomewide association studies (GWAS), genebank data management, seed quality management, *in vitro* conservation, gap analyses and sub-setting with West and Central African NARS partners.
- Genomics tools for genebanks, cryobanking and other conservation techniques with Latin American NARS partners.
- Conservation and use of plant genetic resources in collaboration with the University of Birmingham with partners in Central and West Asia and North Africa (CWANA).
- Plant genetic resources policy training with NARS partners in East and Southern Africa.

CIP has created a community of practice on cryopreservation in Latin America.
Credit: CIP

Work Package progress rating summary

WORK PACKAGE	PROGRESS RATING & RATIONALE
1	**Progress rating** Several milestones reached in ensuring availability and security of collections. ICARDA-Morocco and ICRISAT collections approaching performance targets and two clonal collections close. 89.5 percent of potato clonal accessions are now cryobanked.
2	**Progress rating** Continuous improvement and updating of standard operating procedures in evidence. Landmark workshop in QMS harmonization and genebank data management system. Multispectral imaging of seeds are in the process of being mainstreamed. GHUs developing approaches to deal with cryptic viruses.
3	**Progress rating** Increasing coherence in approaches to improving accuracy and relevance of accession data, including geographical origin, images, environmental and genotypic data. Progress towards developing one portal for selecting and ordering germplasm.
4	**Progress rating** Engagement with NARS partners through multiple approaches, training in regional workshops, on-request technical backstopping, hosting students and national genebank staff, technical support to Crop Trust projects and other targeted project work.

Definitions

On track

- Annual progress largely aligns with Plan of Results and Budget and Work Package theory of change.
- Can include small deviations/issues/delays/risks that do not jeopardize success of Work Package.

Delayed

- Annual progress slightly falls behind Plan of Results and Budget and Work Package theory of change in key areas.
- Deviations/issues/delays/risks could jeopardize success of Work Package if not managed appropriately.

Off track

- Annual progress clearly falls behind Plan of Results and Budget and Work Package theory of change in most/all areas.
- Deviations/issues/delays/risks do jeopardize success of Work Package.

Section 4: **Key results**

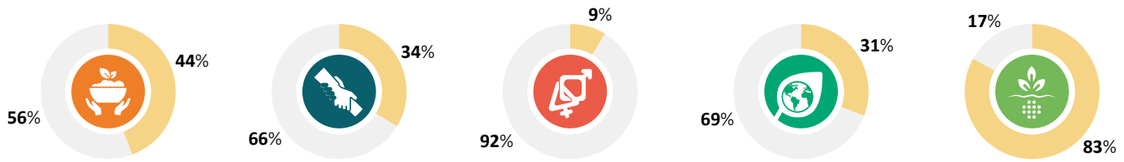
This section provides an overview of results reported by the CGIAR Research Initiative on Genebanks in 2023. These results align with the CGIAR Results Framework and Genebanks' theory of change. Source: *Data extracted from the* CGIAR Results Dashboard *on 29 March 2024*.

Overview of reported results

Outputs

Outcomes

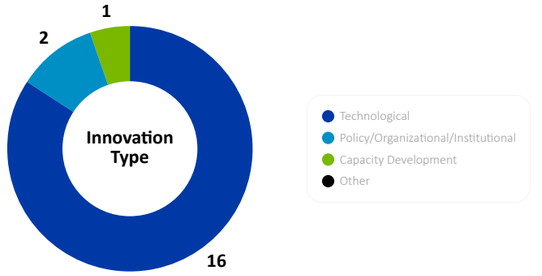
Percentage of reported results tagged to CGIAR Impact Areas

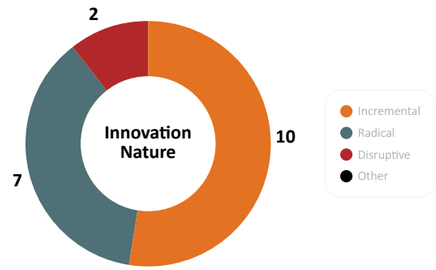


Principal: The result is principally about meeting any of the Impact Area objectives, and this is fundamental in its design and expected results. The result would not have been undertaken without this objective.
Significant: The result has made a significant contribution to any of the Impact Area objectives, even though the objective(s) is not the principal focus of the result.
Not targeted: The result did not target any of the Impact Area objectives.

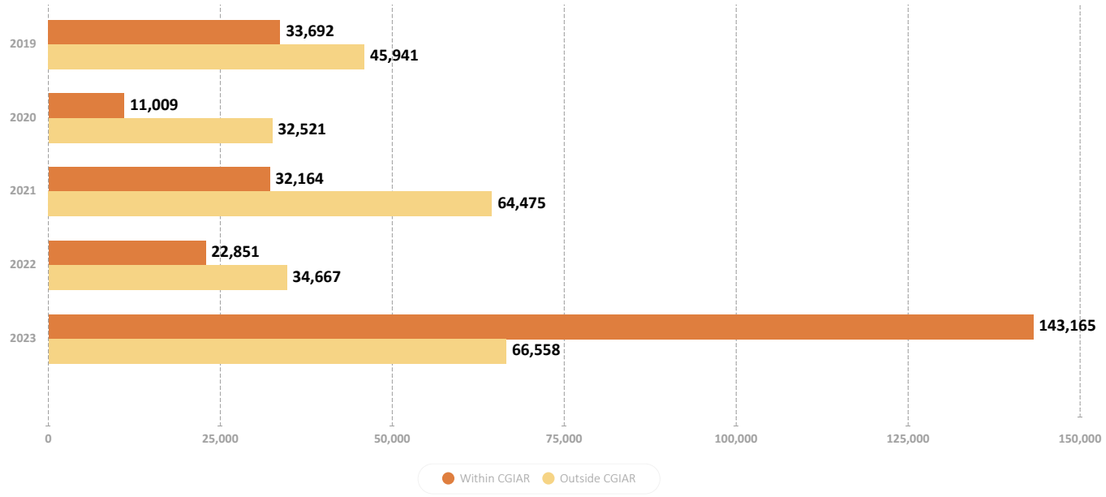
Contributions to the UN Sustainable Development Goals

Number of reported innovations by type and nature

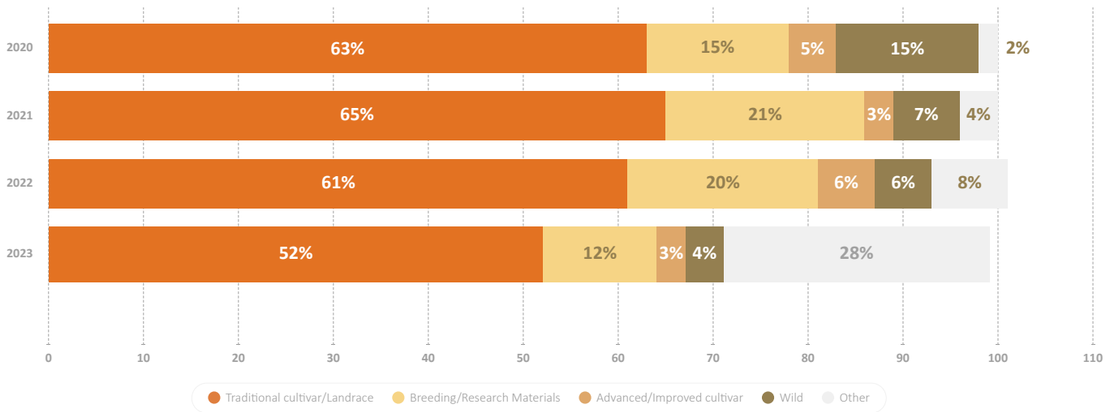




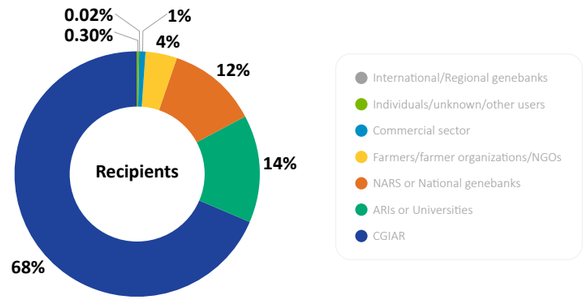
Samples distributed annually by CGIAR genebanks from 2019 to 2023



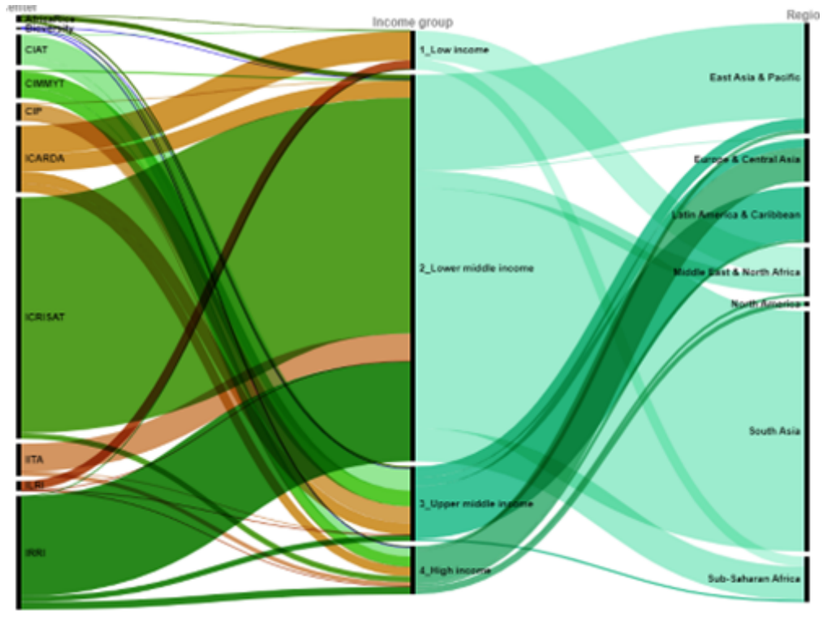
Types of materials requested from 2020 to 2023



Recipients of germplasm distributed by CGIAR genebanks

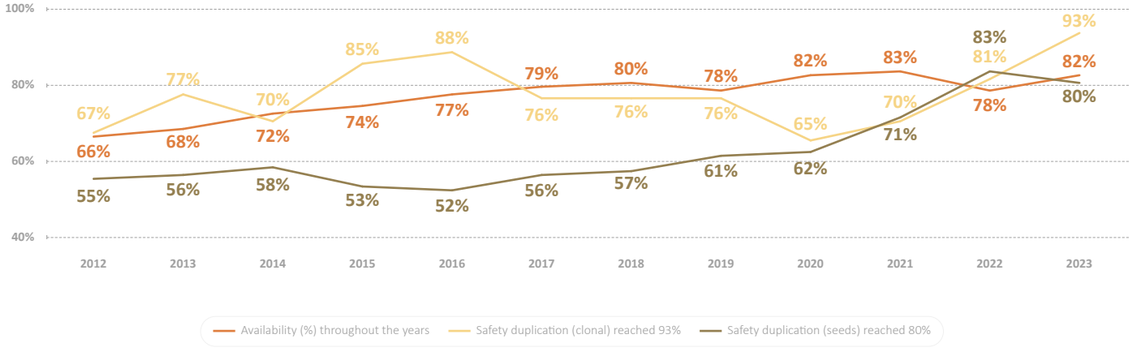


Distribution of germplasm samples from CGIAR genebanks (excluding distributions to CGIAR Initiatives)

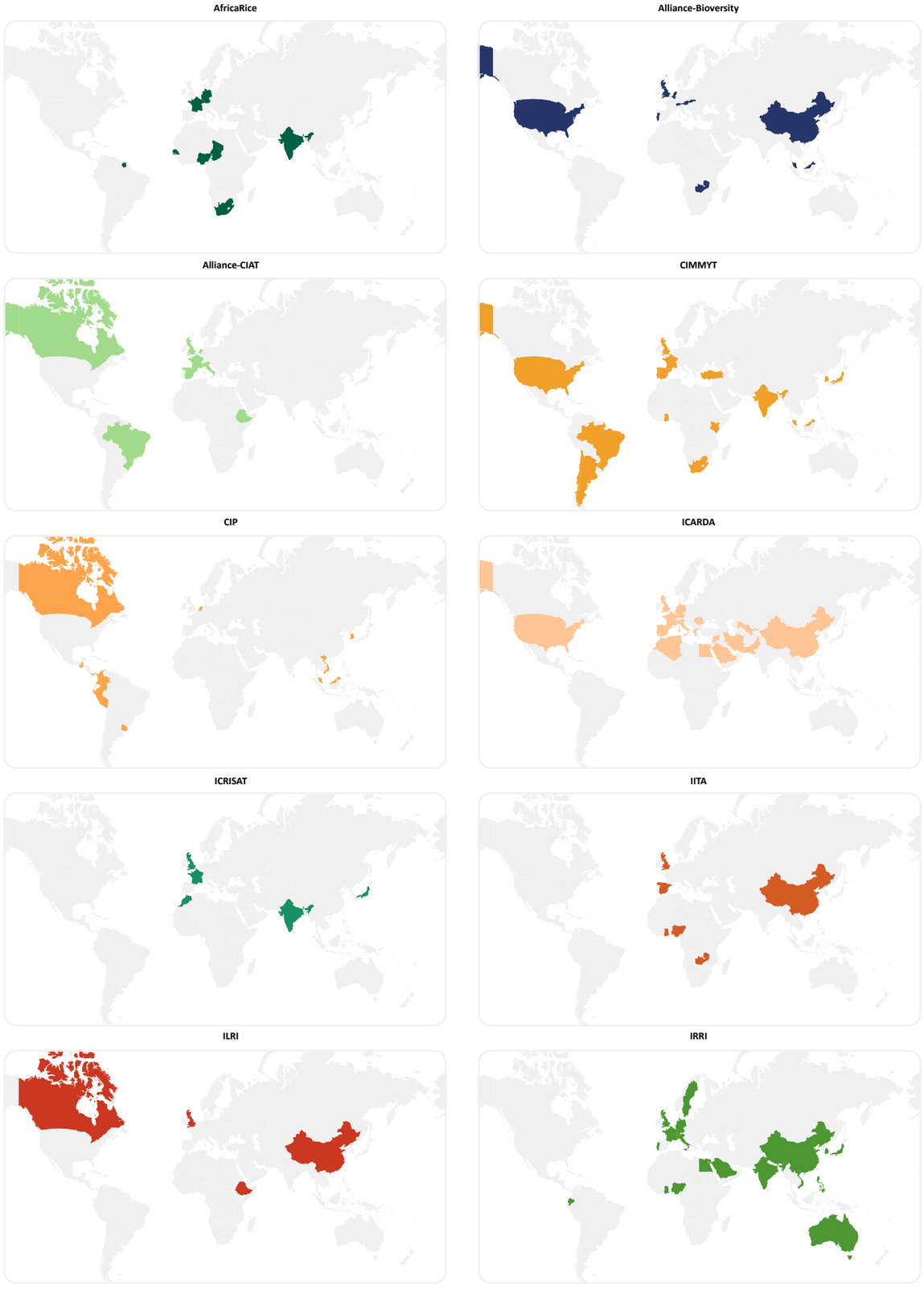


Notes: Income and regional categories are based on World Bank classification 2023-2024

Status (percent) of availability and safety duplication of CGIAR genebanks from 2012 to 2023 (target 90 percent)



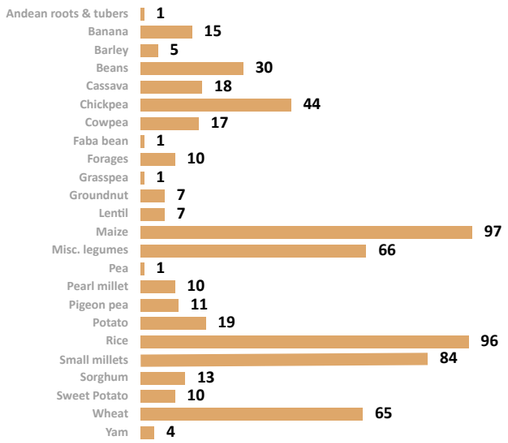
Germplasm external distributions by CGIAR center



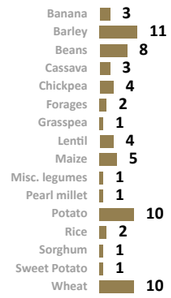
Requests for Germplasm received from outside CGIAR centers

The graphs highlight the purpose of request and the requested crop

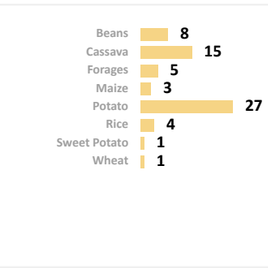
Research (63.65%)



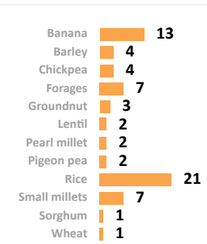
Breeding (6.75%)



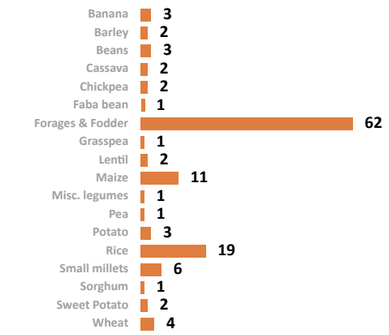
Direct-use (6.45%)



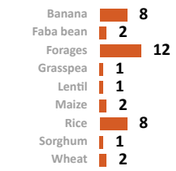
Evaluation (6.75%)



Other purposes (12.67%)



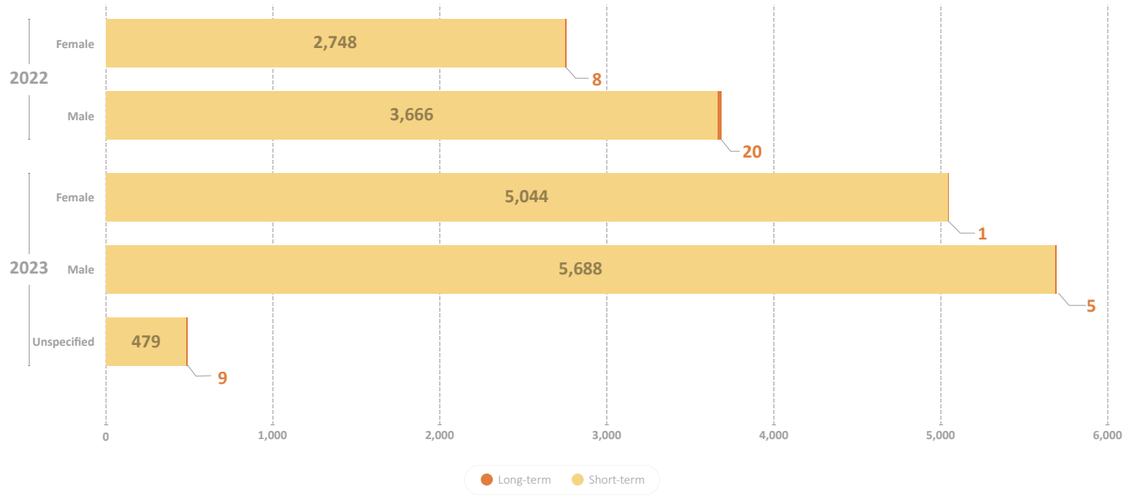
Characterization (3.73%)



Capacity sharing for development results

40	134	11	11,226
Results	Partners	Centers	People trained

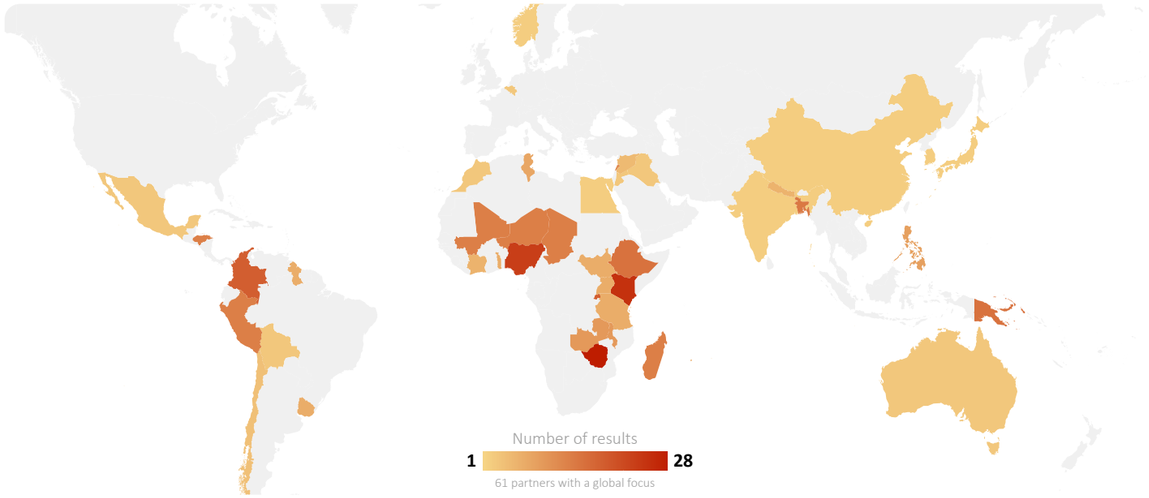
Number of individuals trained by CGIAR



Demonstrating genebank operations to national partners at ICRAF.
Credit CIFOR-ICRAF

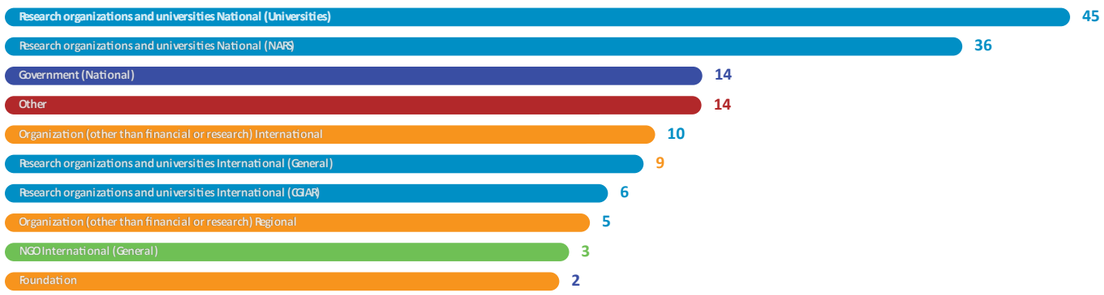
Section 5: **Partnerships**

External Partners Contributing to Results, per Country



Colors represent the number of different partners which collaborated on results achieved in a specific country. One result can impact different countries and therefore the same partner can be associated with more than one country. Source: Data extracted from the Results Dashboard on 29 March 2024.

Top 10 partner typologies that contributed to delivering 2023 results



Partnerships and Genebanks' impact pathways

Partners fall into three main categories:

- Genebank users and beneficiaries.
- Partners in generating data and evaluating germplasm.
- Peers in the genebank community who benefit from sharing capacity or learning from each other's experience.

The graph above depicts mainly peers in the genebank community, who participated in workshops and exchanges or collaborated in writing scientific papers in 2023. However, the genebanks responded to 993 users requesting germplasm from a range of public and private institutions in 68 countries, which are not shown on the map. Services were also provided to NARS and CGIAR colleagues to support accession selection, provide technical backstopping, host safety duplicates, and multiply and clean germplasm.

There are also important international partners. AfricaRice, ICRISAT, ILRI, ICARDA and CIAT all made deposits at the Svalbard Global Seed Vault in 2023, providing a safety back-up of their collections. At year end, 53 percent of the seed packets held at Svalbard came from CGIAR genebanks. The Plant Treaty Secretariat and CGRFA provide policy guidance and set genebank standards and guidelines respectively. The Initiative's work to build capacity in DSI intensified in 2023 in partnership with the DSI Scientific Network (hosted by the Leibniz Institute) and the Periodic Table of Food Initiative. Both participated in joint events with CGIAR and contributed to a range of publications on both technical and policy aspects. The Global Crop Diversity Trust provides long-term funding to all ten reporting genebanks.

Tenth Governing Body meeting of the Plant Treaty.
Credit: Shawn Landersz

Section 6: **CGIAR Portfolio linkages**

In 2023, Process Teams were formed to work on harmonizing data and quality management of seed genebanks such ICARDA's in Lebanon.
Credit: ICARDA

Portfolio linkages and Genebanks' impact pathways

CGIAR genebanks provide germplasm and collaboration on request to many CGIAR scientists in a range of Initiatives and projects. There is also a specific connection with CGIAR breeders and researchers who generate data on genebank accessions. The traceability of these accessions and the associated data remain weak. Although genebanks have adopted accession digital object identifiers (DOIs) minted by the Plant Treaty, they are not used by breeders and too frequently opportunities to associate genebank accessions with new valuable data are lost. Both groups seek approaches to improve this situation.

However, of note in 2023 in terms of Portfolio linkages is the Genebanks Initiative's collaboration with the CGIAR Research Initiative on Breeding Resources (BRI). The two Initiatives are collaborating on and adopting similar approaches, models, templates and tools for QMS harmonization and costing. In addition, the ICARDA genebank made use of the shared services portal, launched by BRI in 2023, to pilot a germplasm ordering portal using the same software platform.

Section 7: **Adaptive management**

RECOMMENDATION	SUPPORTING RATIONALE
Stronger coordination is required in some Work Packages and CoPs.	Phase 4 positions were not recruited nor were the team members who helped coordinate the previous Genebank Platform replaced in the Initiative. Genebank staff, already fully occupied with their existing workloads, cannot provide the levels of coordination required for some Work Packages or CoPs. The Initiative management recognizes the challenge and has hired consultants for some positions. However, the CoP in the new phase 2025-2030 will be designed with adequate coordination.
Policy work should expand to CGIAR scientists beyond genebanks and extend to wider topics including in situ conservation and farmers' rights.	There is increasing demand for policy support to tackle both emerging and longstanding issues concerning plant genetic resources in situ, on farm and ex situ. The small Policy Team plans to scale up to meet their increasing scope. More than 100 staff have now received training through the comprehensive plant genetic resources for food and agriculture policy online course. Trainees should be enabled to become trainers and a community of expertise fostered. A new expert recruitment to the Policy Team in 2024 will also help address this need.
The annual reporting burden placed on genebanks is overwhelming.	Despite ongoing close coordination, the annual reporting and review of genebanks required between the Crop Trust and CGIAR have diverged and increased. This issue is the focus of ongoing discussion between the two organizations and solutions to rationalize reporting requirements will be sought for 2024.

Artificial intelligence helps unearth genebanks' hidden gems

IRRI is screening 60,000 rice samples for resilience to flooding in one year. Three times more than were screened in the previous 52 years.

Rice accessions for screening for flood tolerance at IRRI.
Credit: IRRI

Finding the most valuable samples in CGIAR genebanks has – until now – been a slow, expensive process. IRRI is changing this by using artificial intelligence (AI) to accelerate the screening of its 132,000 rice samples. This will help identify varieties that can tolerate stresses like drought or flooding. It is part of a wider program to curate richer data and insight to help breeders, farmers and researchers make full use of CGIAR's unique collections.

CGIAR genebanks play a vital role in conserving and distributing plant material. But they do much more than that. They also carry out extensive research to help users find the varieties or traits they need.

Traditional methods of evaluating collections are laborious and costly. For example, technicians visually assess seeds against scales in a manual for 80 or more features like "ligule shape" and "leaf blade color intensity". When carrying out field assessments, researchers plant samples one-by-one, carefully marking them with physical labels.

As a result, a lot of the material in genebanks remains untapped as very little is known about their traits and characteristics. In the case of IRRI's genebank, only around 5 percent of the collection has been used in breeding at IRRI. To address this, IRRI is now using technology like AI in the screening process. This makes it possible to generate information about the varieties more quickly, notably about their tolerance of climatic stresses like flooding and drought.

Partly financed by a USD $2 million grant from google.org, IRRI has trained an AI tool to recognize rice samples using images of the seeds. The machine can do this much faster and more reliably than humans. This means that rather than planting the samples individually, taking care to keep them labelled and separated, researchers can sow them in bulk.

To test for flooding tolerance, they then submerge the plants in water and see which ones survive. For drought resilience, they use drones to measure the plants' ability to generate biomass when deprived of water. In both cases, the AI tool makes it easy to work back to the original variety from the seeds of the successful plants.

Using this approach, IRRI is now screening 60,000 of its rice samples for tolerance to flooding in just one year. That would have been unthinkable in the past. Before this project started, only about 20,000 samples had been screened since the genebank opened in 1972. As well as speeding up the process, it will dramatically reduce the costs. IRRI estimates that it should be possible to screen its entire collection for around 6 percent of the cost using the traditional approach.

This type of technique could lead to a step change in how intensively genebank resources are used. If collections can be screened in bulk for some traits, then it could lead to a considerable increase in germplasm distributions from the banks. The Google-funded project contributed to 2023 being a record year for distributions (209,711 samples). When other Centers adopt similar technology, we may well see new records broken.

Using AI for screening is part of a wider program to develop a digital ecosystem for users of CGIAR genebanks. Different users have different needs. Breeders may need detailed genomic and trait information. Farmers may need policy guidelines or information on the environments in which varieties can be grown. The Initiative is therefore developing a range of digital tools so that users have more information to find the precise resources they need.

Multispectral imaging, now in use in six genebanks, is another example of a high throughput imaging process that can be used to identify and describe seeds, other plant materials, and even pathogens. Much faster and more reliable than the human eye and cheaper than DNA barcoding, such imaging methods are changing how genebanks are managed and used.

The Initiative is sharing experience and expertise in using these and other technologies with national genebanks in low- and middle-income countries, leading to more widespread and targeted use of crop diversity around the world.

> Technologies like AI help us find the hidden treasures in genebanks much faster. This unlocks the genebanks' full potential, giving more options to farmers and breeders who need to grow and develop crops that can thrive in a changing climate.
>
> Dr. Venuprasad Ramaiah, Head, Fit-for-Future Genetic Resources, IRRI

Relevant Impact Areas targeted

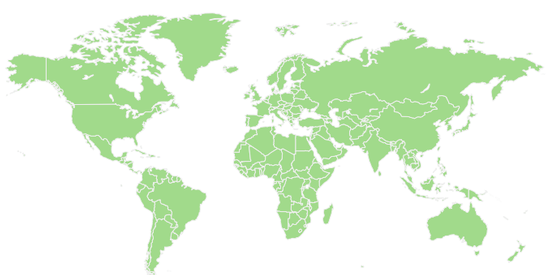
Contributing Center

Primary: IRRI- International Rice Research Institute

Contributing external partners

Japan International Research Center for Agricultural Sciences (JIRCAS) · Okayama University (OU)

Geographic scope



Region: Global

Front cover photo

CGIAR genebanks conserve more than 3,000 species including crop wild relatives.
Credit: ICARDA

Back cover photo

Processing seeds in the CIAT genebank.
Credit: Photo CIAT

CGIAR | INITIATIVE ON Genebanks